

An Atlas of Fertilization and Karyokinesis of the Ovum (1895), by Edmund Beecher Wilson

Edmund Beecher Wilson in the US published *An Atlas of Fertilization and Karyokinesis of the Ovum* (hereafter called *An Atlas*) in 1895. The book presents photographs by photographer Edward Leaming that capture stages of fertilization, the fusion of sperm and egg and early development of sea urchin (*Toxopneustes variegatus*) ova, or egg cell. Prior to *An Atlas*, no one photographed of egg cell division in clear detail. Wilson obtained high quality images of egg cells by cutting the cells into thin sections and preserving them throughout different stages of development. *An Atlas* helped Wilson develop methods to present key stages of fertilization and development, which he later used in his textbook *The Cell in Development and Inheritance*, first published in 1896. Furthermore, *An Atlas* was the first publication to present accurate images of the fertilized egg cell during early stages of development.

Wilson studied cells in the US during the late nineteenth century and early twentieth century. In his three editions of *The Cell in Development and Inheritance*, Wilson organized a vast amount of research related to the cell, including information regarding its structure and its role in cellular development and genetic inheritance. Wilson spent the majority of his career at Columbia University in New York City, New York, where he worked with photographer Edward Leaming in 1885. At the time, Leaming was a medical doctor and an instructor of photography at the College of Physicians and Surgeons at Columbia University.

Wilson published *An Atlas* during a period of many developments in the study of cells. In 1875, researcher Oscar Hertwig in Germany discovered that the nucleus of the sperm cell unites with the nucleus of an egg cell to form a single parent nucleus called a cleavage-nucleus. Hertwig and other cell researchers during the nineteenth century presented their discoveries in text and often included drawings or other diagrams to illustrate, but nearly all lacked photographs. Prior to Wilson's *An Atlas*, other scientists had published photographs of egg cells. However, Wilson claimed that their images had unacceptably blurry resolution.

Wilson's *An Atlas* consists of a preface, a general introduction, and a descriptive section. In the preface and general introduction, Wilson provides background information regarding the book as well as an overview of its contents. In the descriptive section, Wilson presents photographs and diagrams of the egg cell throughout different stages of development. In that section, Wilson includes a total of forty photographs on ten photographic plates. Wilson presents them with respect to the order in which the stages occur during fertilization. The first plate contains images of the egg cell prior to fertilization. Subsequent plates contain images of the various stages of fertilization, and the last plate contains photographs of the newly divided cells after fertilization.

In Wilson's preface, he explains developments in the study of cells during the latter half of the nineteenth century. Those developments included increased explanations of the fertilization of the egg and of how nuclei divide. Because those phenomena require microscopes to observe them, Wilson states that it is difficult to teach the subject to a wide audience. Wilson says that scientists typically represent microscopic phenomena in texts as drawings. However, he claims that drawings are a subjective form of visual aid due their reliance on the artist's interpretation of natural events. He then explains that he uses photographs rather than illustrations in *An Atlas* to depict cells because photographs, unlike drawings, provide an objective representation of cellular phenomena.

Wilson concludes the preface by stating the methods he and Leaming used to obtain the photographs. The methods included cutting very thin sections of a sea urchin (*Toxopneustes variegatus*) egg cells

during key stages in development and preserving and staining them to make cellular structures visible when viewed through a microscope. By cutting the cells into thin sections, Wilson and Leaming obtained high resolution images and avoided the blurry image problem that others had encountered years before. Following Wilson's preface, Leaming provides a more technical explanation of the photographic techniques employed, such as the lens that he used and details about the exposure and focus used to obtain the photographs.

In the general introduction of *An Atlas*, Wilson discusses fertilization and karyokinesis, the division of the cleavage-nucleus. Wilson explains that the introductory section of *An Atlas* aims for an audience of students and general readers. He provides a brief summary of the union of egg and sperm nuclei and the distribution of genetic material during the maturation, fertilization, and division, also called cleavage, of the egg cell.

Following the introductory section, Wilson transitions into a descriptive section, where he presents the plates containing the photographs alongside text describing the stages of fertilization. In addition to the photographs, Wilson includes camera lucida drawings that were rendered from the photographs. Camera lucida is a drawing aid that uses mirrors to superimpose the subject of a drawing onto a separate drawing surface, which enables an artist to trace a photo-realistic illustration. Despite his initial criticisms about the drawbacks of drawings, Wilson states that his are unlike typical scientific drawings in that his use of a camera lucida provides an accurate representation of the real object. Wilson also acknowledges that drawings can provide better textual context when carefully constructed and refined to produce an ideal model of the phenomena being described.

Many recognized the importance of Wilson's *An Atlas* for the study and teaching of cellular biology. In 1895, author Charles Sedgwick Minot at Harvard Medical School in Boston, Massachusetts, published a book review in the journal *Science* describing Wilson's work as being one of the most notable productions of pure science in the US. In another book review published in 1896 by the *British Medical Journal*, the editors credit Wilson and Leaming with providing a valuable series of images and illustrations.

The images Wilson used in *An Atlas* influenced his later work. In his book *The Cell in Development and Inheritance* first published in 1896, Wilson presented drawings and diagrams based on the photographs he and Leaming had included in *An Atlas*. Wilson and Leaming's photographic techniques also went on to provide a new method of scientific illustration of biological processes.

Sources

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